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# Does admission to hospital affect trends in survival and dependency after stroke using the South London Stroke Register?

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Table II: Appendix 1 (ONLINE SUPPLEMENT) : Factors influencing 1-year outcome (1: BI<15 or dead,0: BI>=15) for patients with first-ever stroke

**Abstract**

**Background and Purpose**: Despite guidelines for specialist assessment in hospital for stroke, it is important to identify patient characteristics, trends and outcome in patients not admitted to hospital compared with patients admitted to hospital.

**Methods**: Population based stroke register of first in a life time strokes between 1995 and 2012 were examined. Baseline data included admission or non admission, case mix, stroke subtype and risk factors before stroke. Survival curves were estimated with Kaplan-Meier methods. Logistic regression was used to determine factors associated with poor outcome (dead and dependency: Barthel Index (BI) <15) at three months and one year.

**Findings**: 3464 patients were admitted to hospital for stroke. Patients admitted were more likely have more severe impairments (P<0.001). There was a significant trend for increasing admission over time; 1995-2000 (82%), 2001-2006 (90%) and 2007-2012 (94%), P<0.001. When survival analysis was stratified according to BI ≥ 15 at day seven, there no significant differences in survival curves between admission and non admission groups in 1995-2000 (P=0.15) or 2001-2006 (P=0.06) but there was a significant trend for higher survival rates for non admission in the 2007-2012 cohort (P=0.025). Admission to hospital (stroke unit) compared with non admission was also associated with poor outcome in the 2001-2006 time period (OR: 2.66, CI: 1.17 to 6.04) and the 2007-12 time period (OR: 5.26, CI: 1.27 to 21.81).

**Conclusion**: There is a survival advantage from 2007 onwards and lower levels of dependency from 2001 onwards after adjusting for case mix for those patients who are not admitted to hospital, which requires further explanation.

## Introduction

Admission to hospital and access to specialist stroke services is a cornerstone of high quality stroke care (1). National and international guidelines in stroke that we are aware of have supported the approach that patients with suspected stroke should be admitted to hospital to receive a range of evidence based interventions (1,2,3). Despite this consensus, non admission rates for stroke patients vary between 15% to 22% (4,5).

Previous data from the South London suggested that death and disability were more likely to occur in patients who were admitted to hospital for stroke compared with patients who were not despite adjustment for case mix (4). It was hypothesised that aspects of hospital care may have been detrimental which required further exploration. However a randomised controlled trial comparing stroke unit care, in-patient stroke team care and avoidance of hospital admission, demonstrated that mortality at three months was significantly lower for patients assigned to stroke unit (6).

Over the past two decades, there has been a policy drive for increasing admission for stroke predominately fuelled by guidelines highlighting access to acute specialist care, although many directives are now focusing efforts in reducing emergency admissions for a number of other conditions despite equivocal evidence (1,7). It is therefore important to identify patient characteristics of those who do not seek hospital admission for stroke and to ascertain whether they receive evidence based interventions. The aims of this study are to explore the trends, the processes of care and differences in outcome between patients admitted to hospital versus non-admission after first ever stroke using a population stroke register in South London.

## Methods

### Identification of Patients

Data for this analysis were derived from the South London Stroke Register (SLSR), a population-based stroke register that has prospectively recorded first-ever strokes in patients within a geographically defined area of South London since 1995. Hospital surveillance for stroke included two teaching hospitals within and three outside the study area. Methods of patient notification and data collection have been described previously (8,9). **Multiple, overlapping sources were used to register non-admitted stroke patients and admitted stroke patients** by trained study nurses/ fieldworkers. **All general practitioners within and on the borders of the study were contacted regularly and asked to notify the South London Stroke Register of patients. Regular communication with general practitioners was achieved by telephone contact and quarterly newsletters. Referrals of non admitted stroke to a neurovascular clinic or domiciliary visit to patients by the study team was also available to general practitioners. Community therapists were also contacted regularly (**8,9**).** Data collected between 1995 and 2012 were used in this analysis. At the 2001 census, the population of the SLSR area was 271817 (63% whites; 9% black Caribbean; 15% black African and 13% other ethnic groups). Stroke diagnosis, using the World Health Organisation clinical definition was verified by study clinician and patients were examined within 48 hours of referral. Patients who died prior to admission and incurred a stroke whilst in hospital were excluded from the analysis. All patients and /or their relatives gave written informed consent to participate in the study. Very few patients had declined to be registered (1%).

**Socio-demography and Case mix**

Socio-demographic data collected included: age; gender; ethnic origin (1991 Census question) stratified into white, black (black-Caribbean, black African, and black other), and other ethnic group; socioeconomic status (manual and non-manual occupation). **Clinical details at the time of maximal impairment within 72 hours of onset were obtained (swallowing: using the 3-oz water swallow test and urinary incontinence). Level of consciousness was assessed using the Glasgow Coma Score (GCS) dichotomized into GCS <13 (impaired consciousness) and GCS ≥ 13 (10).** Activities of daily living prior stroke were assessed using the Barthel Index (BI) and were classified as 0-14 (moderate/severe disability), 15-20 (mild disability/independent) (11). Stroke subtype was categorised using the Oxford Community Stroke Project classification: Total anterior circulatory infarction (TACS), partial anterior circulatory infraction (PACI), posterior circulatory infarction (POCI), lacunar infarction (LACI), primary intracerebral haemorrhage (PICH), subarachnoid haemorrhage (SAH) or unclassified stroke (no pathological confirmation of stroke subtype) (12).

**Prior Risk factors**

Prior history of hypertension (>140 mmHg systolic or > 90 mmHg diastolic), diabetes mellitus, atrial fibrillation, previous TIA, alcohol drinking status (yes/no) and smoking history (current, ex-smoker, never smoked) and previous ischaemic heart disease was recorded from general practice or hospital records.

**Effective interventions after stroke**

Patients were classified as 1) not admitted to hospital; 2) admitted/transferred to stroke unit at any time during hospital admission and 3) admitted to non stroke unit (managed in a general medical/geriatric ward). We examined a range of indicators of the process of care after an acute stroke suggested to be useful proxy measures for quality of stroke care (13). These included access to brain imaging (computed tomography –CT, magnetic resonance imaging- MRI or both), swallow assessment, the use of antihypertensive agents during the first three months of stroke as well as the use of antiplatelet, anticoagulant and cholesterol lowering agents in ischaemic stroke during the same time period.

**Outcome measures**

Outcome as measured by the BI was categorised into good (BI ≥15) and poor (death or dependency **(moderate/ severe)** –BI 0-14) (11). These were assessed 7 days, 3 months, and at one, 5 and 10 years after stroke. Survival time was calculated from date of stroke to date of death.

**Statistical Methods**

Data were available from 1st January 1995 and we were able to obtain complete records up to 31st December 2012. We included all index cases up to 31st December 2012 and incorporated follow-up until 31st May 2013. Survival time was confirmed by the Office for National Statistics. Patients with no record of death were censored at 31st May 2013. Continuous variables were summarised as mean (standard deviation) and categorical data as percentage. **One way ANOVA** was used to test differences in continuous variables where appropriate, and the Chi-square test used for proportions. Survival curves were made among stroke patients by consecutive time periods (per 6 years), ethnic groups and for those with BI Scores ≥ 15 at day 7 using the Kaplan-Meier method (unadjusted) and log rank tests. Multivariate survival analyses were undertaken using Cox Proportional-Hazards models to determine the prognostic value of socio-demographic factors, case mix, stroke subtype, effective intervention, and risk factors before stroke. The event studied was all-cause mortality. The prognostic value of socio-demographic factors, case mix, effective intervention and prior to stroke risk factors for 3 month and one year outcome was also examined by using multivariate logistic regression. Sensitivity analyses were carried out to assess possible effects of missing data by comparing the observed and complete case analyses with missing data analyses using various imputation methods, where missing data for survivors were imputed at all time points using a best- and then worst-case scenario for binary outcomes. Loss to follow-up rates varied by time point (after accounting for deaths): 3 months (24%) and 1 y (17.9%). All tests were 2-tailed, and p-value < 0.05 was considered statistically significant. Hazard ratios (HR) with 95% confidence interval (CI) for prognostic factors were calculated in Cox models, while

odds ratios (OR) with 95% CI were calculated in multivariate logistic models. All statistical analyses were performed with statistical software R, version 2.15.2.

**Results**

Between January 1995 and December 2012, 3459 of a total of 3917 patients with first ever stroke were admitted to hospital and 458 (12%) patients were managed in the community. Table 1 describes the socio-demographic characteristics, case mix, stroke subtype, risk factors prior to stroke and process of stroke care between patients admitted to hospital and non admitted patients. Patients admitted to hospital (stroke unit, non stroke unit) were younger compared to those not admitted (69.9 years vs. 68.6 years vs. 71 years) (P=0.002). Patients of black African Caribbean origin (P<0.0001) were more likely to be admitted. Patients not admitted were more likely to have a prior history of hypertension (P=0.03), be a current smoker (P<0.0001) and current drinker of alcohol (P<0.0001) compared with patients admitted to hospital, however there was a higher frequency of atrial fibrillation in patients admitted to hospital (P=0.0005). Patients admitted had more severe clinical impairments for stroke such as incontinence, GSC<13, failed swallow and being disabled at day 7 (Barthel Index < 15) compared with non admitted patients (P<0.0001). There were significant differences in stroke subtype between both groups with higher rates of TACI and PICH in admitted patients but lower rates of LACI in this group (P<0.0001). The swallow test was less likely to be performed in non admitted patients (23.1%) compared with admitted patients to stroke units (7.2%) and non stroke unit admitted patients (11.7%)(P<0.0001). Brain imaging consisting of both CT/MRI was also more likely to occur in admitted stroke unit patients (37.5%) compared to admitted non stroke unit patients (12.7%) and non admitted patients (12%)(P<0.0001).

Appendix 1(Table I) illustrates an increasing trend for admission to hospital over the 18 year period: 1995-2000 (82%), 2001-2006 (90%) and 2007-2012 (94%,) (P<0.001). When comparing characteristics across the 6 year time periods, non admitted patients became younger. Increasing trends of black African Caribbean patients not admitted were observed across all time periods. In this study 23% (1995-2000), 67% (2001-2006 and 82% (2007-12) of patient were managed in stroke units. The distribution of the day 7 Barthel Index < 15 for non admitted patients were 1995-2000 (13.5%), 2001-2006 (11%) and 2007-2012 (6.3%). The distribution of combined brain imaging using CT and MRI for admitted patients (stroke units) was 7.9% (1995-2000), 15.1 % (2001-2006) and 74.1 % (2007-12).

Among the 3917 patients with first ever stroke between January 1995 and December 2012, the median survival was 40.5 months (stroke units) compared with 40.4 months (non stroke units) and 80.4 months (non admission) (P<0.0001). The 7 day case fatality rate was 13.1% (stroke units) compared with 22.7% (non stroke units) and 0.4% (non admission) (P<0.0001). 90 day case fatality rate was 23.9 % (stroke units) compared with 37.8% (non stroke units) and 2.6% (non admission) (P<0.0001).

When we compared patients registering in each consecutive 6 year period from 1995 to 2012, we found that survival was overall greater for non admission compared to admitted patients in the Kaplan Meier analysis (log rank test P<0.0001) with an overall improvement in survival over time for each period (P<0.0001) (Figure 1a). When further analysis was stratified by ethnicity, there was a survival advantage for non admitted patients for both white (P<0.0001), black Caribbean patients (P=0.01) but not black African patients (P=0.44). However for the whole cohort, when the analyses were stratified by day 7 Barthel Index ≥ 15 as a measure of case mix, there

was no survival advantage between the groups (P=0.09) Figure 1b. When this analysis was stratified by each 6 year period, the survival advantage for non admission was shown in the most recent cohort of 2007-2012 (log rank test P=0.025).

Factors affecting all cause mortality are described in Table 2 across 6 year time periods. Multivariate survival analysis showed that increasing age, severe clinical impairments for stroke (GCS <13, urinary incontinence and failed swallow) and atrial fibrillation across all cohorts was associated with mortality. Being African Caribbean in the 1995-2000 period (HR: 0.7, 95% CI 0.58 to 0.85) and the 2001-2006 (HR: 0.73, 95% CI 0.59 to 0.91) period was associated with improved survival. Non stroke unit management compared with non admission was associated with increased mortality across all time periods after adjusting for potential confounding factors. Stroke unit management compared to non admission was associated with increased mortality in all time periods but was significant in the 2007-12 time period (HR: 7.56, 95% CI 2.47 to 23.13) after adjusting for confounding factors.

Appendix 1 (Table II) shows the factors associated with poor outcome for each 6 year period at one year after adjusting for case mix. Increasing age and severe clinical impairments for stroke were associated with poor outcome across all time periods. Management in non stroke units compared with non admission was more likely to be associated with poor outcome in the 2001-2006 time period (OR: 4.04, 95% CI 1.69 to 9.67) and the 2007-12 time period cohort (OR: 12.61, 95% CI 2.67 to 59.67). Management in stroke units compared with non admission was also associated with poor outcome in the 2001-2006 time period (OR: 2.66, 95% CI 1.17 to 6.04) and the 2007-12 time period (OR: 5.26, 95% CI 1.27 to 21.81). After 3 months (full data not

shown), although the direction of the effects was similar across all time periods, there were no significant effects of non admission on poor outcome.

Figure 2 shows the distribution of poor outcomes (death and dependency: BI <15) and good outcome (BI ≥15) across all time points of 7 days, 3 months, 1 year, 2 years, 5 years and 10 years. Poor outcomes were evident across all time points for admitted patients compared with non admitted patients.

At 3 months, of the 2094 admitted patients with ischaemic stroke, 368 (17.6%) were not prescribed antiplatelet agents compared with 37 (9.4%) of the 392 patients who were not admitted (P=0.02). Similarly, 760 (36.3%) of admitted stroke patients were not prescribed cholesterol lowering agents compared with 164 (41.8%) who were not admitted (P<0.001). Of the 351 patients who were admitted to hospital for ischaemic stroke and were in atrial fibrillation only 97 (27.6%) were prescribed warfarin compared with 4 (8.5%) of the 47 patients who were not admitted (P=0.008). There were no differences in antihypertensive prescription between the 333 patients admitted with known hypertension (73.6%) versus the 44 patients not admitted (81.8%), P=0.32.

**Discussion**

This is the largest detailed study to date analysing the differences in stroke patients admitted to hospital compared with non admitted patients in an unbiased population of in South London. The main finding from this study is that admitted patients had worse survival and poorer outcomes than stroke patients who did not seek hospital admission after adjusting for confounding variables. This is at odds with the randomised controlled trial by Kalra and colleagues where stroke unit admission was shown to be more effective than home support as well as mobile stroke team support for patients in a highly selected population of moderately severe strokes recruited within 72 hours (6). In addition to this, the study was conducted during 1995-1999 before widespread uptake of evidence based interventions.

As the prognosis of the groups is not comparable it is necessary to adjust for case mix variables in this non randomised comparison due to confounding by treatment indication. We have however adjusted for many of the case mix variables suggested by Davenport and colleagues as well as validated case mix variables that have been shown to be predictive of poor outcome and are sufficient in quality and precision (14). **These included age, sex, prior stroke Barthel Index, living conditions and socio-economic status, stroke subtype, clinical assessments of maximal impairment (GCS, failed swallow, incontinence) and prior stroke risk factors**. It is however possible that some confounding factors remain unadjusted for such as markers of frailty, physiological variables and more detailed measures of case mix such as Charlson and APACHE scores (15). Even when careful case mix adjustment is made using clinical data on stroke severity, no allowance can be made for a bias that exits between different types of patients using different services. **It is also possible that since the clustering of patients within hospitals was not taken into**

**account, unmeasured differences between hospitals may also account for some of the observed differences in admission and outcomes.** There are also other factors that may differ between both groups, which may influence complex decision making for hospital admission, including patient choice, general practitioner advice, policy for local stroke services and availability of resources (16).

There are a number of possible interpretations to explain poorer outcomes for hospital admission. It has been acknowledged that hospital admission may be associated with a number of hazards which includes malnutrition, sleep deprivation, risk of infection, pain, falls, prescription of new drugs which can lead to deconditioning as a result of loss of physiological homeostasis, particularly in older patients (17). Krumholz and colleagues warn that many patients who are hospitalised are not only recovering from their acute illness within a complex pathway but are susceptible and exposed to a period of heightened risk for a wide range of adverse health events (17,18). It is also possible that patients are being discharged from hospital with higher levels of disability into the community and this may account for their worse outcomes.

Although there is a strong evidence base that stroke units improves outcome, there was low uptake of such units in the earlier cohorts but a clear trend of improvement in the provision of these services. It is therefore possible that a significant proportion of patents were not in receipt of the important processes of care that are beneficial for stroke patients (19). Interestingly antiplatelet therapy was used less at 3 months in admitted patients compared with non admitted patients.

There was evidence of increasing hospital admission over time with a decreasing trend of the proportion of patients who were disabled at day 7 (BI <15) managed in hospital. This can be explained by increasing public awareness of stroke through

campaigning and the reorganization of stroke care in London promoting emergency access to hospital (20). In the latter cohort (2007-2012), there was an increasing trend of higher rates of black Caribbean patients being managed in the community. Previous data from the South London Stroke Register have demonstrated that black African Caribbean patients have a survival advantage over White groups, particularly in the over 65 year olds and this may explain in part the survival advantage of non admission in the latter cohorts (21).

In the latter cohort (2007-2012), patients who were not admitted were fewer in number, milder in severity and had better outcome compared to earlier cohorts. In patients with non disabling stroke, prompt specialist assessment is recommended but guidelines do not specifically detail in which setting this should occur (1). **In a study comparing outpatient management of minor ischaemic stroke with admission, there was no difference in 30 day admission rates for non admitted patients and 30 day readmission rates post discharge from hospital with lower costs with avoiding admission (22). In addition to this, higher rates of secondary prevention measures were used in non admitted patients.** It therefore could be argued that for certain types of stroke patients there is no evidence that avoiding admission leads to poorer outcome.

Any general conclusion regarding poorer outcomes for admitted patients needs to be tempered by lower rates of statins and anticoagulation therapy use for patients not admitted to hospital and it has been argued that admission to hospital may facilitate and reinforce secondary prevention compliance (22). The lower rates of swallow assessment in this group may reflect the timing and delay of specialist assessment. There were also lower rates of combined brain imaging overall in non admitted

patients although there were similar rates of brain imaging for the latter cohort. This is in keeping with the need for MRI brain imaging required for greater sensitivity for mild stroke in particular lacunar stroke.

There are strengths and limitations to this observational cohort study. The data were derived from a multi-ethnic population based register whose outcomes had previously been described using the 1995-98 cohort but now has the advantage of studying a large sample size of almost 4,000 patients over a 18 year period with long term follow up data, allowing statistical power to determine differences in survival and functional outcome in both groups. The strength of these analyses is the collection of processes of care variables over time with inclusion of new processes as the evidence for their use becomes established across different time periods. The loss to follow-up rates, once deaths are accounted for, in this study are around 20% at each time point. This loss to follow up may introduce bias, yet estimates from analyses of the patients with complete data did not differ significantly from those presented here. In many cohort and stroke register studies, loss to follow up rates are not often presented. We also acknowledge that Inner city populations such as in South London are mobile with large numbers of migrant families which can make follow up challenging. Other reasons include the inability to complete follow up due to cognitive impairment and refusal of patients to be assessed repeatedly. Efforts were also made for all patients' changes of address to be recorded from hospital, general practice or family sources. If patients had moved to another country, postal questionnaires were often sent and returned (9).

The use of the Barthel Index at day seven as a categorical measure of case severity can be argued but results from analyses using dichotomized BI did not differ

significantly from that using continuous BI. The ceiling and floor effects of the BI are acknowledged although this index is recognized in clinical studies and trials as an appropriate measure. Any patient experiencing stroke should be in receipt of specialist stroke care from the outset as soon as possible with the best evidence continuing to support stroke unit (1). The results of our analysis do not support that hospitalisation for stroke should be avoided but it does generate hypotheses suggesting that potential hazards may exist with hospital admission and that for some patients with mild stroke, non admission with appropriate specialist intervention may be feasible and beneficial. **Conversely, if non admission for stroke is considered particularly for patients with mild stroke, it is vital that access to specialist's assessments, diagnostics and secondary prevention are received**. Randomised trials comparing non admission with urgent outpatient management versus hospital admission may be warranted in the future but may be difficult to conduct in the current arena of hyper-acute stroke care.



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**Conflicts of interests:** None

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| Table 1: Baseline characteristics of patients with first-ever stroke: non admission vs. hospital admission vs. stroke unit | | | | |
|---|---|---|---|---|
| | **Non admission (n=458) 12%** | **Hospital admission but non stroke unit (n=1398) 36%** | **Stroke unit (n=2061) 52%** | **P-value** |
| **Age** | 71(12) | 68.6(16.5) | 69.9(14.6) | 0.002 |
| **Year of stroke: 1995-2000** | 259(56.6%) | 927(66.3%) | 355(17.2%) | <0.0001 |
| **2001-2006** | 136(29.7%) | 337(24.1%) | 876(42.5%) | |
| **2007-2012** | 63(13.8%) | 134(9.6%) | 830(40.3%) | |
| **Sex: Male** | 237(51.7%) | 683(48.9%) | 1066(51.7%) | 0.22 |
| **Ethnicity: White** | 340(74.2%) | 1015(72.6%) | 1370(66.5%) | <0.0001 |
| **Black** | 75(16.4%) | 253(18.1%) | 528(25.6%) | |
| **Others/unknown** | 43(9.4%) | 130(9.3%) | 163(7.9%) | |
| **Socioeconomic status: Non-manual** | 130(28.4%) | 344(24.6%) | 600(29.1%) | <0.0001 |
| **Manual** | 275(60%) | 740(52.9%) | 1051(51%) | |
| **Others/unknown** | 53(11.6%) | 314(22.5%) | 410(19.9%) | |
| **Living condition: Private alone** | 134(29.3%) | 405(29%) | 677(32.8%) | <0.0001 |
| **Private not alone** | 227(49.6%) | 626(44.8%) | 1061(51.5%) | |
| **Institution** | 25(5.5%) | 106(7.6%) | 144(7%) | |
| **Others/unknown** | 72(15.7%) | 261(18.7%) | 179(8.7%) | |
| **Case mix: Glasgow Coma Scale (< 13)** | 2(0.4%) | 455(32.5%) | 493(23.9%) | <0.0001 |
| **Incontinent of urine** | 24(5.2%) | 701(50.1%) | 808(39.2%) | <0.0001 |
| **Prior Barthel < 15** | 25(5.5%) | 97(6.9%) | 103(5%) | 0.045 |
| **Post Barthel < 15 (7d)** | 54(11.8%) | 613(43.8%) | 967(46.9%) | <0.0001 |
| **Stroke subtype: TACI** | 2(0.4%) | 175(12.5%) | 333(16.2%) | <0.0001 |
| **PACI** | 102(22.3%) | 275(19.7%) | 605(29.4%) | |
| **POCI** | 68(14.8%) | 161(11.5%) | 214(10.4%) | |
| **LACI** | 221(48.3%) | 301(21.5%) | 512(24.8%) | |
| **PICH** | 2(0.4%) | 226(16.2%) | 272(13.2%) | |
| **SAH** | 1(0.2%) | 162(11.6%) | 27(1.3%) | |
| **Unclassified/unknown** | 62(13.5%) | 98(7%) | 98(4.8%) | |
| **Swallow test: fail** | 9(2%) | 581(41.6%) | 692(33.6%) | <0.0001 |
| **Swallow test: not assessed** | 106(23.1%) | 164(11.7%) | 148(7.2%) | <0.0001 |
| **Brain imaging: CT scan only** | 276(60.3%) | 1025(73.3%) | 1169(56.7%) | <0.0001 |
| **MRI scan only** | 55(12%) | 77(5.5%) | 88(4.3%) | |
| **CT& MRI** | 55(12%) | 178(12.7%) | 773(37.5%) | |
| **Unknown** | 72(15.7%) | 118(8.4%) | 31(1.5%) | |
| **Risk factors prior to stroke: Hypertension** | 305(66.6%) | 792(56.7%) | 1301(63.1%) | 0.003 |
| **Myocardial infarction** | 41(9%) | 139(9.9%) | 181(8.8%) | 0.36 |
| **Atrial fibrillation** | 44(9.6%) | 233(16.7%) | 302(14.7%) | 0.0005 |
| **Previous TIA** | 51(11.1%) | 164(11.7%) | 220(10.7%) | 0.41 |
| **Diabetes** | 89(19.4%) | 213(15.2%) | 401(19.5%) | 0.014 |
| **Current smoker** | 158(34.5%) | 463(33.1%) | 607(29.5%) | <0.0001 |
| **Drinker** | 255(55.7%) | 763(54.6%) | 1022(49.6%) | <0.0001 |

| Table 2: Factors influencing all-cause mortality among for patients with first-ever stroke # | | | |
|---|---|---|---|
| | **HR (95%CI) (1995-2000)** | **HR (95%CI) (2001-2006)** | **HR (95%CI) (2007-2012)** |
| **Age (year)** | 1.05(1.04,1.06)* | 1.05(1.05,1.06)* | 1.04(1.03,1.05)* |
| **Female (vs. Male)** | 0.91(0.8,1.04) | 0.94(0.8,1.1) | 1.04(0.81,1.34) |
| **Ethnic group (vs. White):** | | | |
| **Black** | 0.7(0.58,0.85)* | 0.73(0.59,0.91)* | 0.84(0.6,1.16)* |
| **Others/unknown** | 0.67(0.5,0.89)* | 0.78(0.59,1.03) | 0.87(0.58,1.3) |
| **Socioeconomic status (vs. Non-manual):** | | | |
| **Manual** | 1.04(0.9,1.21) | 1.14(0.96,1.36) | 1.18(0.87,1.62) |
| **Others/unknown** | 1.49(1.22,1.83)* | 1.27(1.01,1.59)* | 1.41(1,1.97)* |
| **Case mix:** | | | |
| **Glasgow Coma Scale (GCS) < 13** | 1.74(1.47,2.06)* | 1.74(1.42,2.14)* | 1.61(1.16,2.22)* |
| **Unknown GCS** | 0.81(0.35,1.87) | 0.61(0.36,1.03) | 1.29(0.66,2.52) |
| **Incontinent of urine** | 1.48(1.25,1.74)* | 1.27(1.03,1.56)* | 1.44(1.06,1.96)* |
| **Unknown urine status** | 1.15(0.79,1.69) | 1.55(1.11,2.17)* | 3.74(2,6.98)* |
| **Prior Barthel < 15** | 1.07(0.84,1.37) | 1.05(0.79,1.4) | 1.1(0.76,1.59) |
| **Unknown prior Barthel** | 0.45(0.25,0.81)* | 0.88(0.57,1.35) | 1.16(0.78,1.73) |
| **Post Barthel(7 days) < 15** | 1.02(0.85,1.21) | 1.17(0.96,1.44) | 2.51(1.75,3.59)* |
| **Unknown post Barthel** | 2.23(1.81,2.75)* | 2.81(2.21,3.58)* | 2.62(1.76,3.92)* |
| **Stroke subtype (vs. TACI):** | | | |
| **PACI** | 0.85(0.69,1.04) | 0.73(0.57,0.94)* | 1.19(0.83,1.73) |
| **POCI** | 0.99(0.77,1.27) | 0.78(0.57,1.07) | 1.02(0.61,1.7) |
| **LACI** | 0.85(0.69,1.06) | 0.72(0.55,0.95)* | 1.08(0.69,1.69) |
| **PICH** | 1.03(0.82,1.29) | 0.96(0.73,1.25) | 1.67(1.08,2.6)* |
| **SAH** | 1.72(1.2,2.45)* | 0.66(0.43,1.04) | 0.95(0.38,2.38) |
| **Unclassified/unknown** | 1.25(0.87,1.78) | 0.75(0.47,1.19) | 1.29(0.75,2.2) |
| **Hospital admission but non stroke unit vs. non admission** | 1.27(1.04,1.55)* | 2.07(1.51,2.83)* | 16.39(5.33,50.45)* |
| **Stroke unit vs. non admission** | 1.06(0.84,1.34) | 1.25(0.91,1.7) | 7.56(2.47,23.13)* |
| **Swallow test:** | | | |
| **fail** | 1.39(1.18,1.63)* | 1.46(1.2,1.78)* | 1.38(1,1.9)* |
| **Unknown** | 1.38(0.99,1.92) | 0.7(0.52,0.95)* | 1.56(1.08,2.26)* |
| **Brain imaging (vs. CT only):** | | | |
| **MRI only** | 0.95(0.7,1.27) | 0.75(0.53,1.06) | 0.74(0.34,1.62) |
| **CT and MRI** | 1.04(0.79,1.36) | 0.59(0.43,0.82)* | 0.96(0.74,1.24) |
| **No scan** | 1.89(1.39,2.57)* | 2.18(1.39,3.43)* | 0.43(0.1,1.82) |
| **Risk factors prior to stroke:** | | | |
| **Hypertension** | 0.91(0.8,1.04) | 1.13(0.97,1.33) | 0.69(0.53,0.88)* |
| **Myocardial infarction** | 1.27(1.06,1.53)* | 1.23(0.97,1.55) | 1.63(1.12,2.38)* |
| **Atrial fibrillation** | 1.36(1.16,1.6)* | 1.48(1.22,1.79)* | 1.65(1.23,2.21)* |
| **Previous TIA** | 1.07(0.91,1.26) | 0.97(0.78,1.2) | 0.96(0.64,1.45) |
| **Diabetes** | 1.45(1.23,1.71)* | 1.31(1.09,1.59)* | 0.99(0.72,1.36) |
| **Current smoker** | 1.06(0.91,1.22) | 1.53(1.27,1.85)* | 1.03(0.76,1.4) |
| **Smoking status unknown** | 1.2(0.85,1.69) | 1.58(1.17,2.14)* | 0.57(0.35,0.92)* |
| **Drinker** | 1.13(0.98,1.29) | 0.83(0.7,0.97)* | 1.23(0.93,1.64) |
| **Unknown** | 0.63(0.47,0.85)* | 1.19(0.88,1.61) | 3.87(2.47,6.07)* |

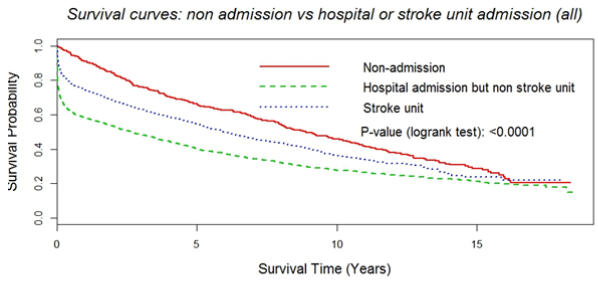
*** Adjusted for sociodemographic/socioeconomic factors, case mix (severe clinical impairments for stroke), effective interventions (stroke unit, non admission, swallow assessment, stroke subtype, brain imaging and risk factors prior stroke**

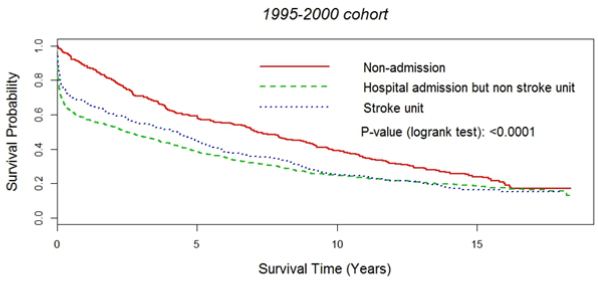
*** indicates significant hazard ratio**

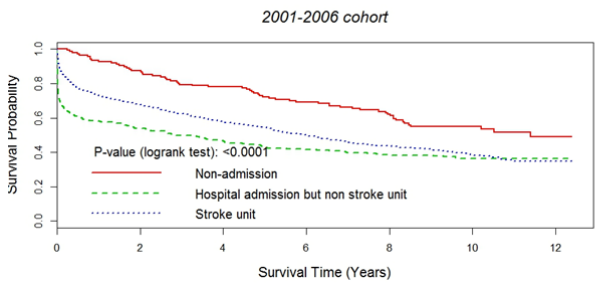
Figure 1a: Kaplan Meier survival estimates by admission versus non admission

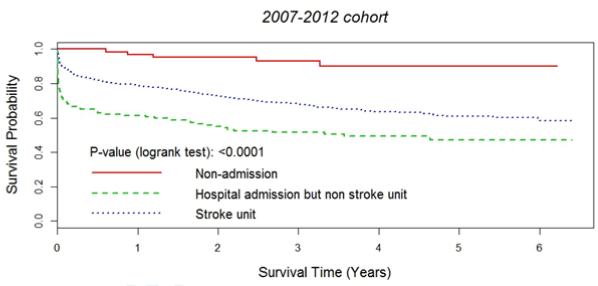
Figure 1b: Kaplan Meier survival estimates by admission versus non admission stratified by Barthel Index ≥ 15 at day 7

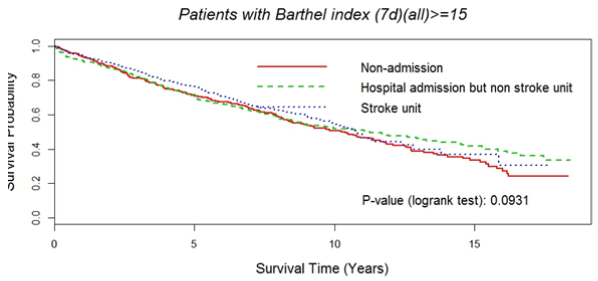
Figure 2: Distribution of poor outcome (dead and Barthel Index < 15)

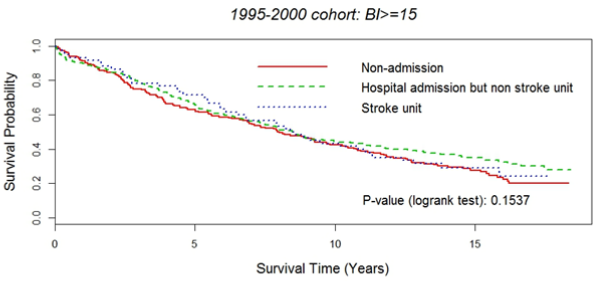

Survival curves: non admission vs hospital or stroke unit admission (all)
Survival Probability
Survival Time (Years)
Non-admission
Hospital admission but non stroke unit
Stroke unit
P-value (logrank test): <0.0001

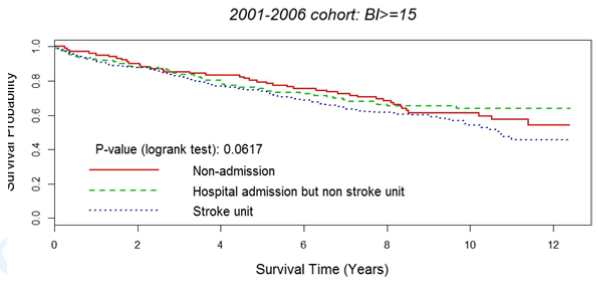

1995-2000 cohort
Survival Probability
Survival Time (Years)
Non-admission
Hospital admission but non stroke unit
Stroke unit
P-value (logrank test): <0.0001

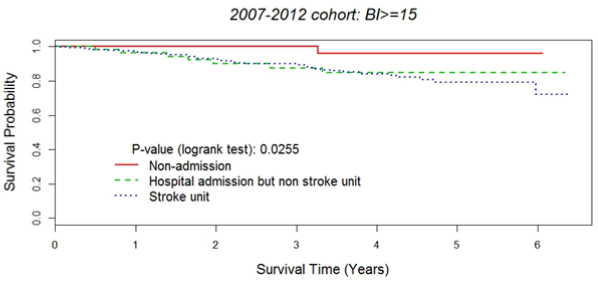

2001-2006 cohort
Survival Probability
Survival Time (Years)
P-value (logrank test): <0.0001
Non-admission
Hospital admission but non stroke unit
Stroke unit


2007-2012 cohort
Survival Probability
Survival Time (Years)
P-value (logrank test): <0.0001
Non-admission
Hospital admission but non stroke unit
Stroke unit


Patients with Barthel index (7d)(all)>=15
Survival Probability
Survival Time (Years)
Non-admission
Hospital admission but non stroke unit
Stroke unit
P-value (logrank test): 0.0931


1995-2000 cohort: BI>=15
Survival Probability
Survival Time (Years)
Non-admission
Hospital admission but non stroke unit
Stroke unit
P-value (logrank test): 0.1537


2001-2006 cohort: BI>=15
Survival Probability
Survival Time (Years)
P-value (logrank test): 0.0617
Non-admission
Hospital admission but non stroke unit
Stroke unit


2007-2012 cohort: BI>=15
Survival Probability
Survival Time (Years)
P-value (logrank test): 0.0255
Non-admission
Hospital admission but non stroke unit
Stroke unit